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(54) **V-CHANNEL CLAMP**

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Publication Classification

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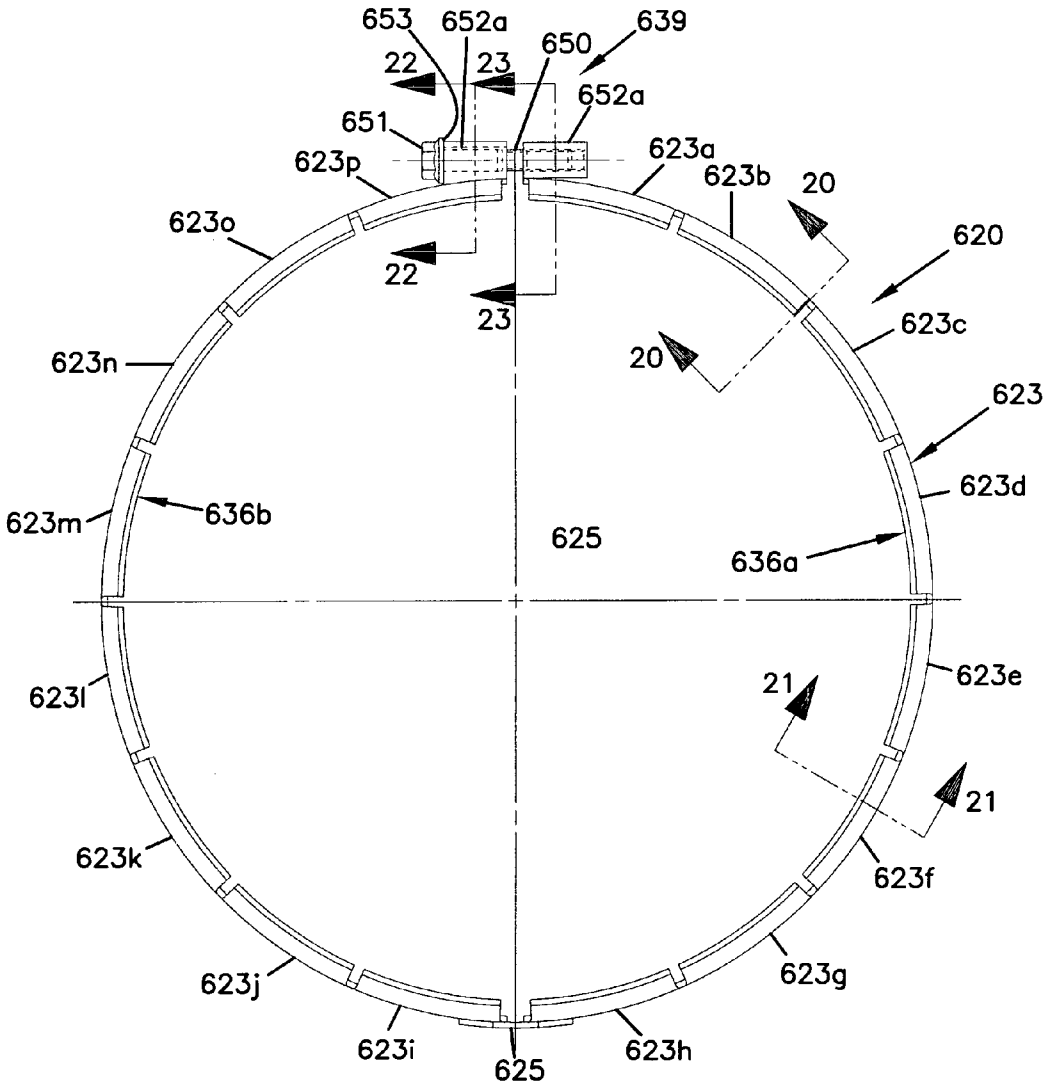
F16L 23/00 (2006.01)

(52) **U.S. Cl.** **24/19**; 285/407

(57) **ABSTRACT**

The present disclosure relates to a clamp including a channel structure having a generally v-shaped cross-section. Notches can be provided through the channel structure to enhance flexibility. A sleeve and bolt fastening arrangement can be used to tighten the clamp.



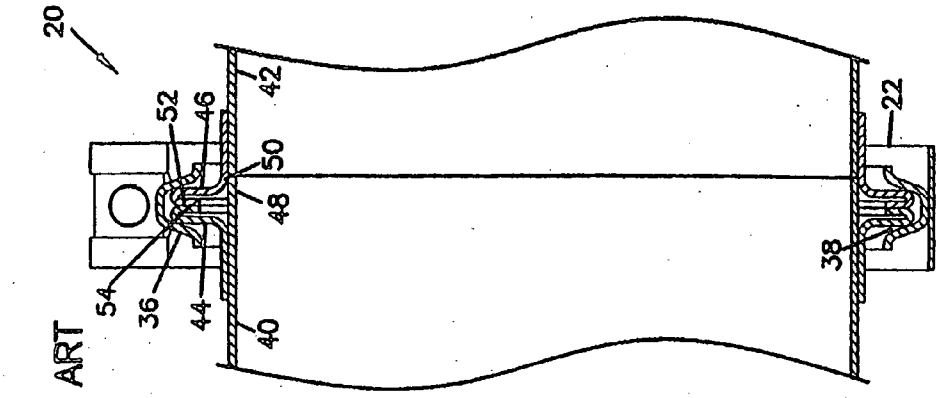


FIG.2
PRIOR ART

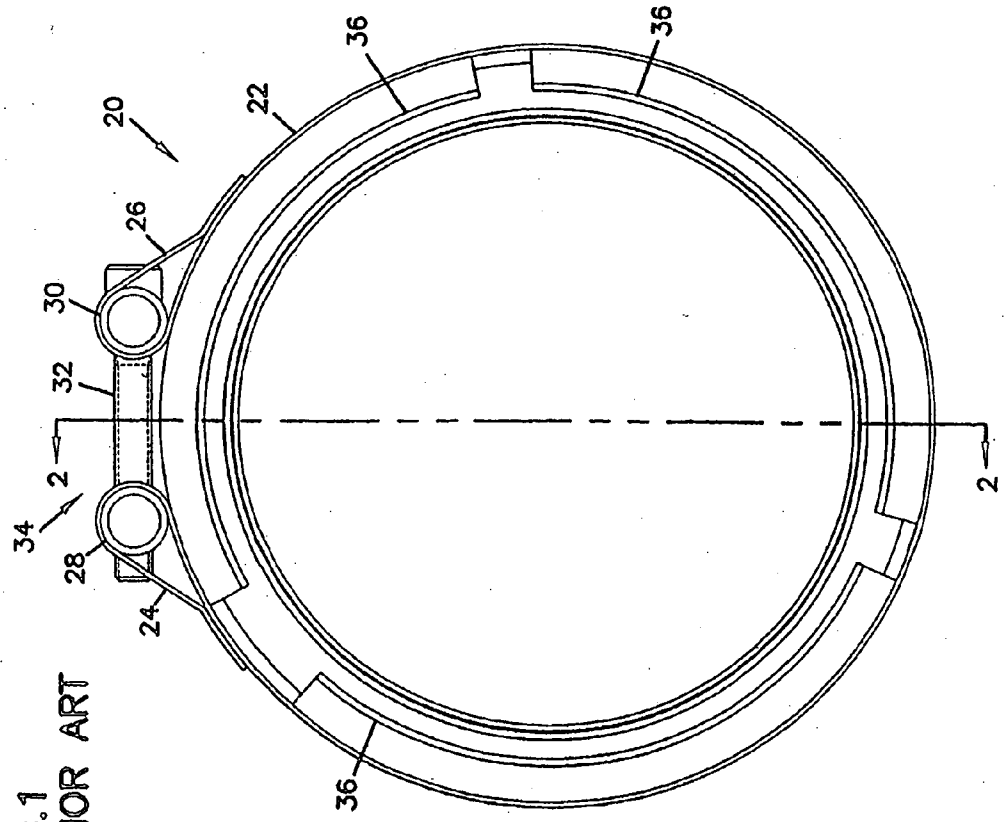
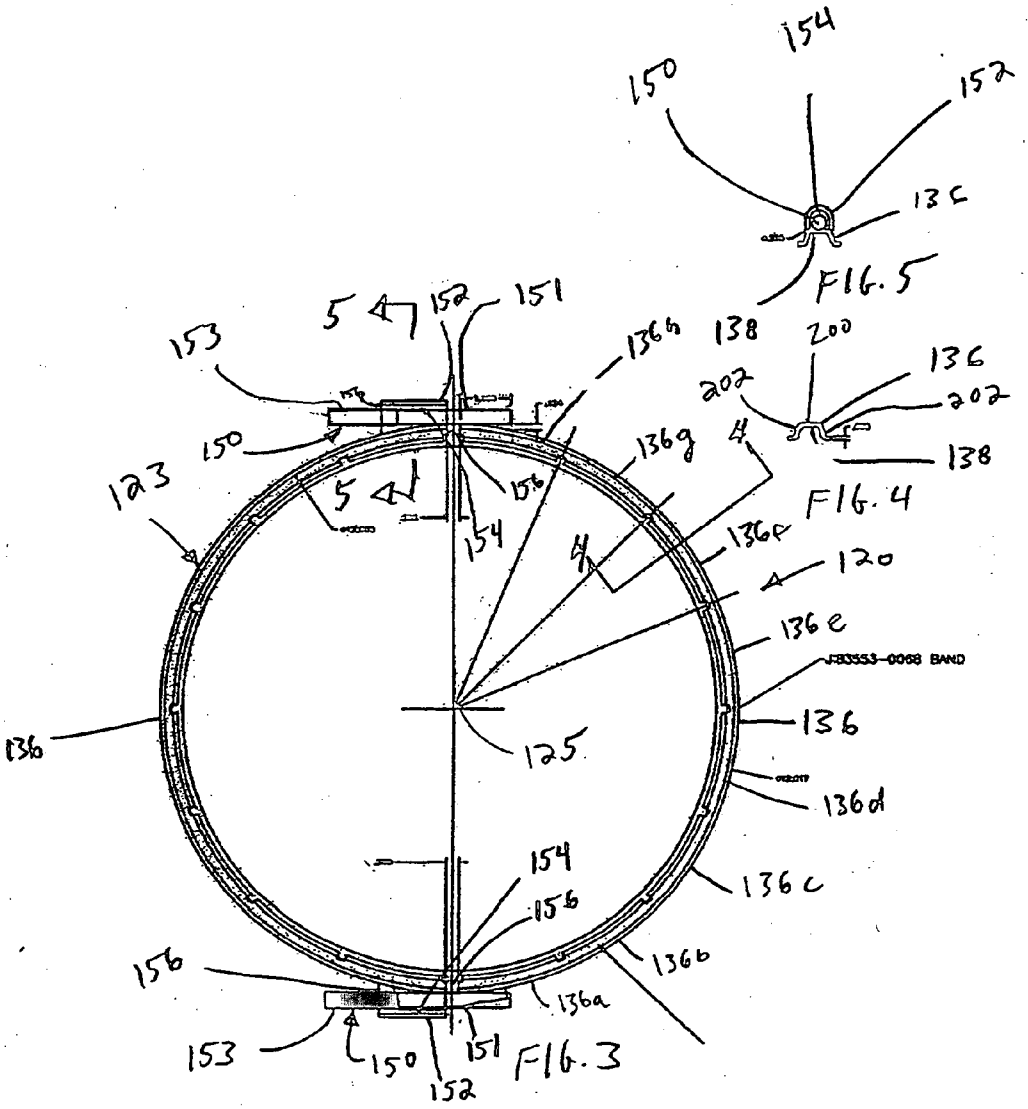


FIG.1
PRIOR ART


154
150
152
136
138
FIG. 5
200
202
136
202
138
FIG. 4
5
152
151
153
136b
136g
150
123
154
136f
120
136e
136
125
136d
136c
156
136a
153
150
151
152
FIG. 3

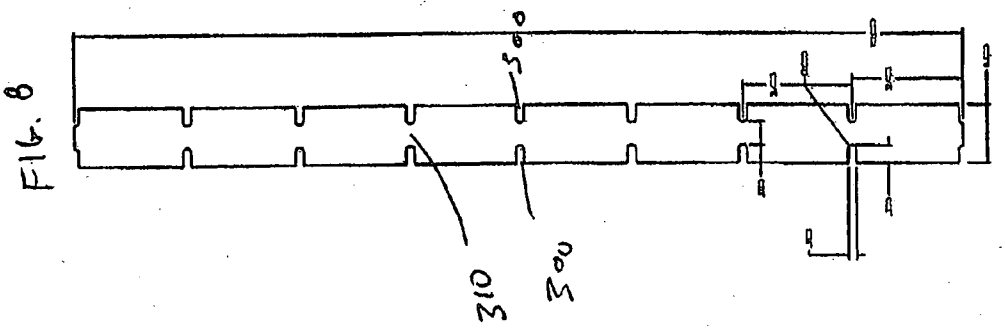


FIG. 8

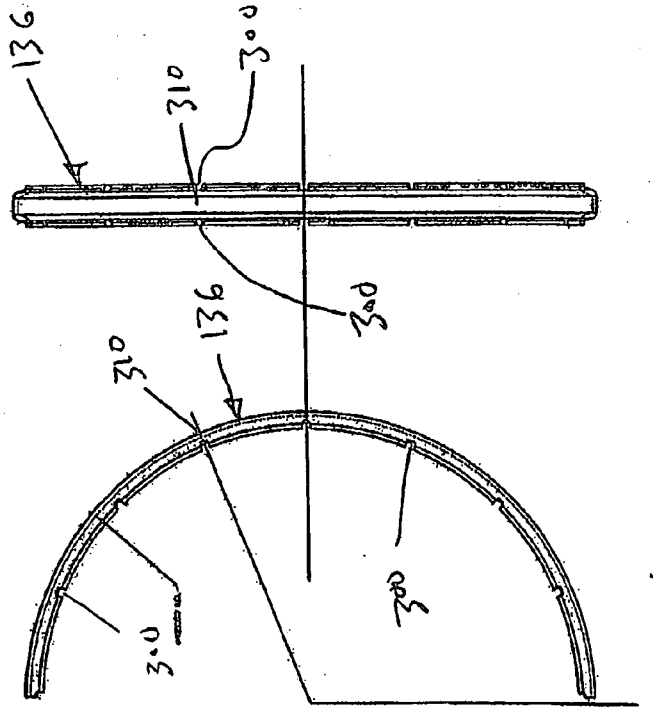


FIG. 7

FIG. 6

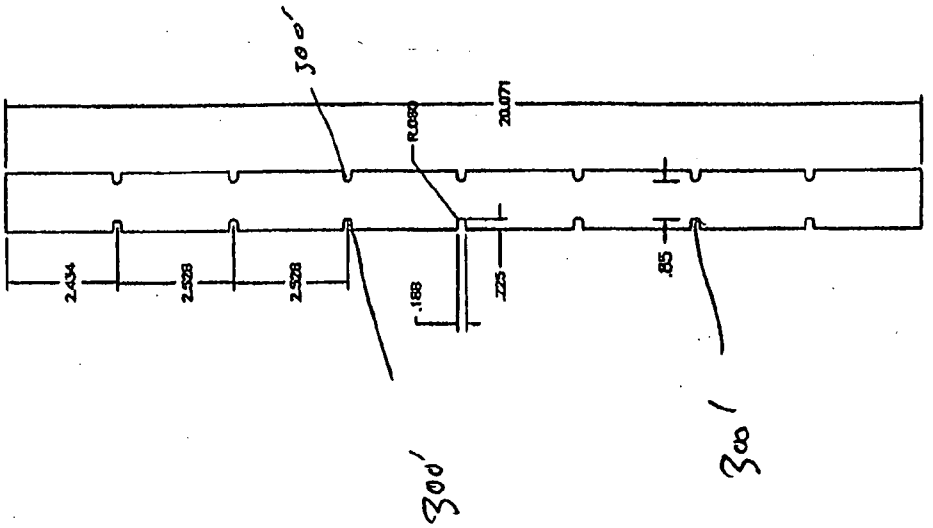


FIG. 12

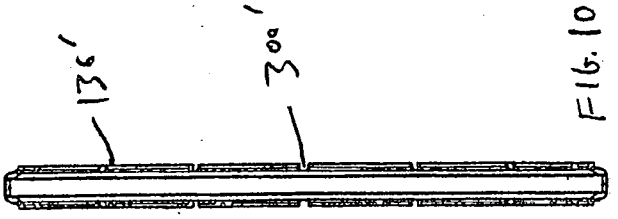


FIG. 10

FIG. 11

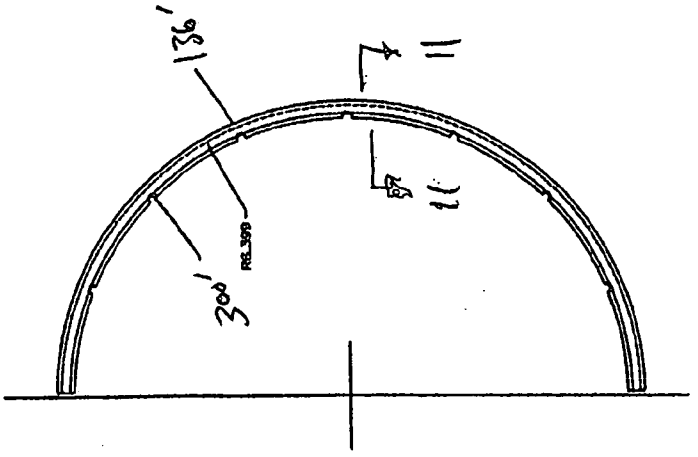


FIG. 9

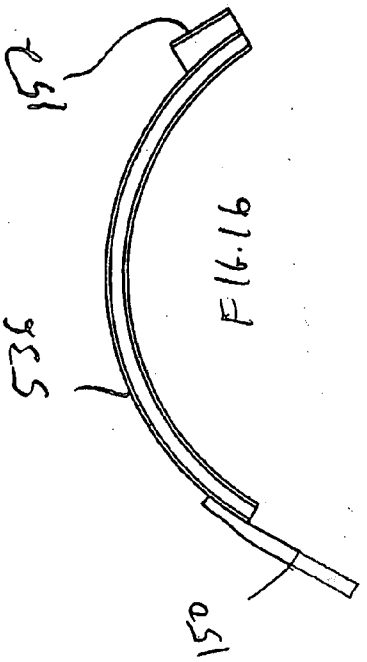


FIG. 16

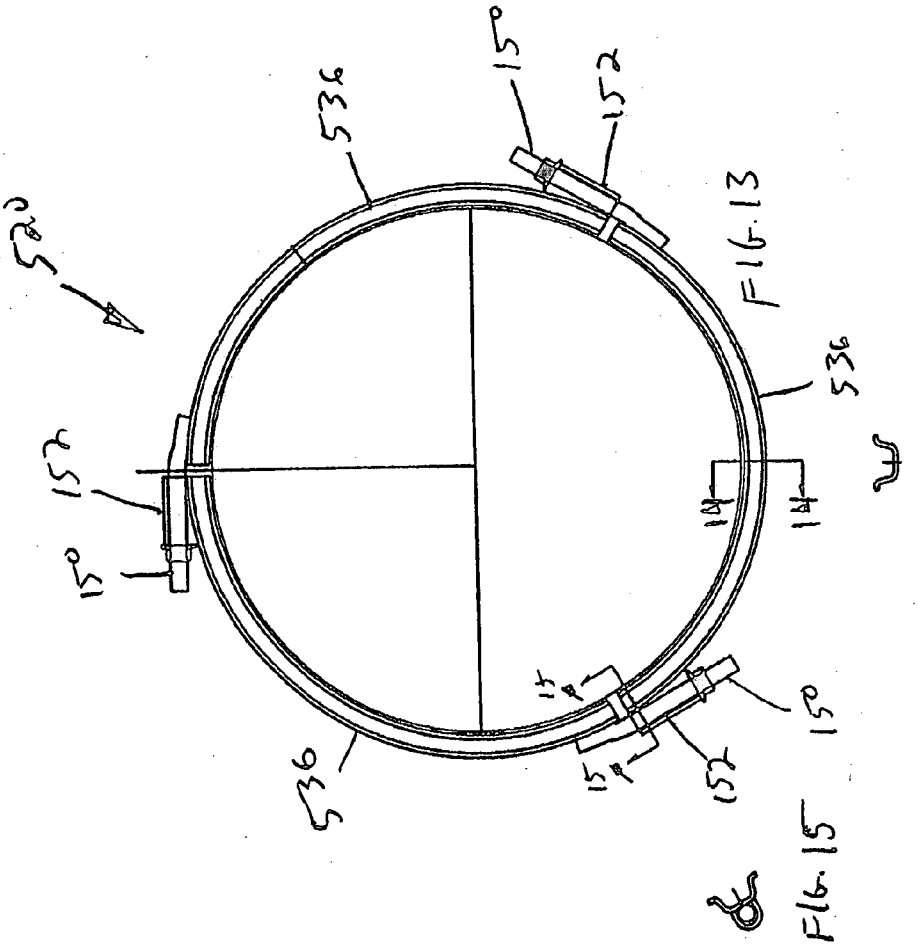


FIG. 13

FIG. 14

FIG. 15

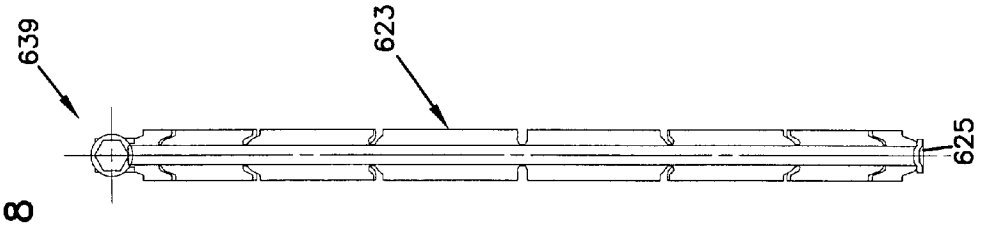

639
623
625

FIG.18

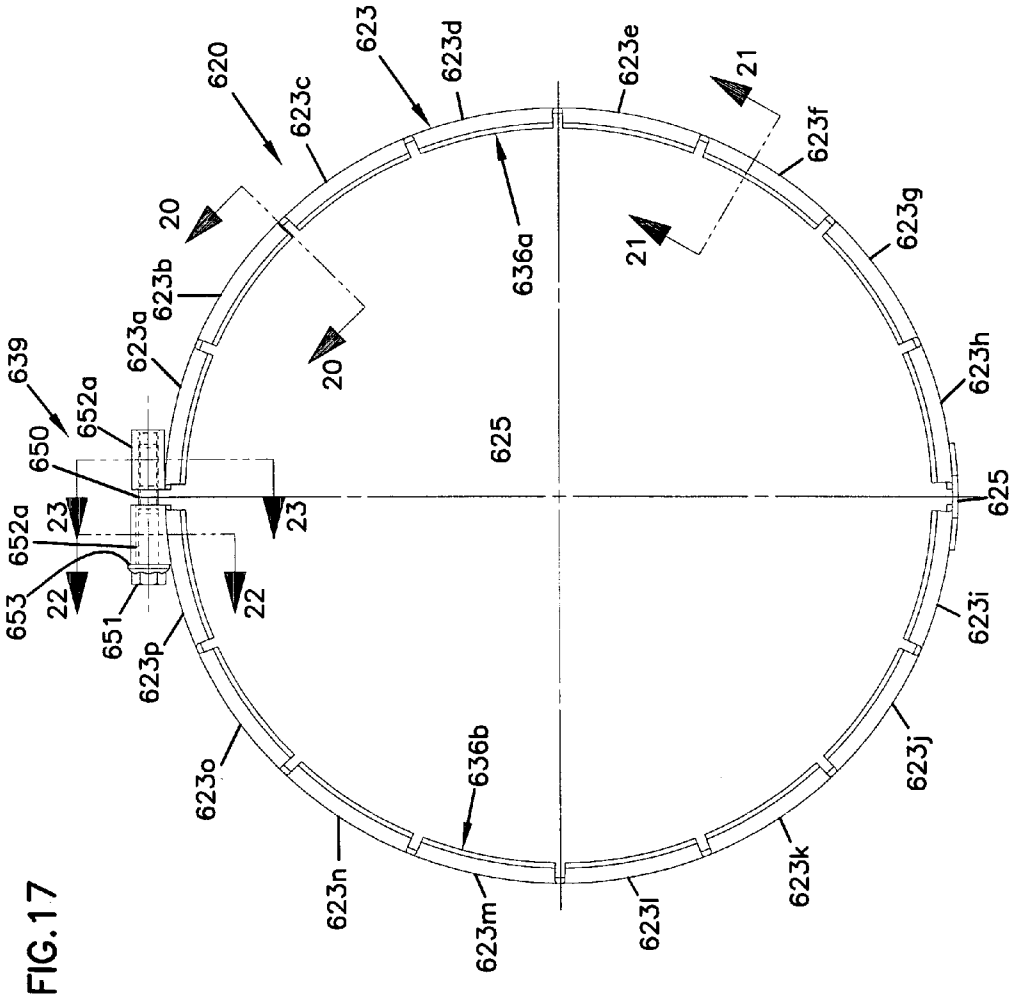

620
623c
623
623d
623e
21
623f
623g
623h
623i
623j
623k
623l
623m
623n
623o
623p
623a
623b
20
636a
636b
625
639
650
652a
653
651
22
23

FIG.17

FIG.22

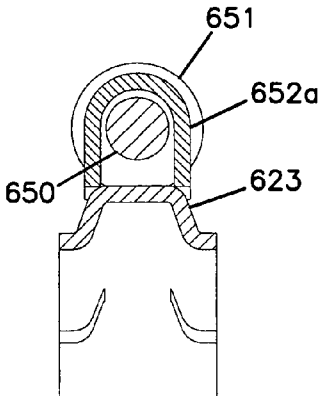


FIG.23

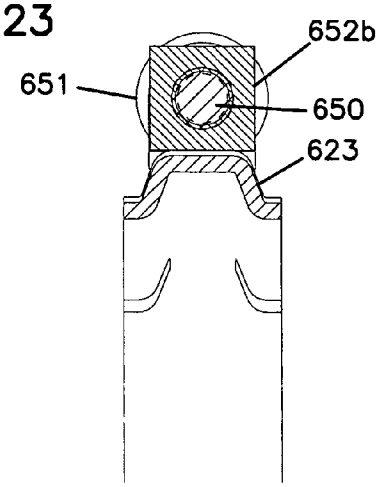


FIG.20

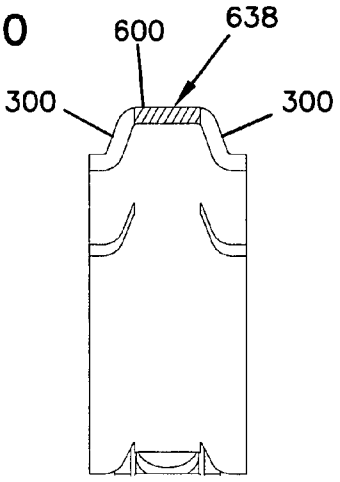


FIG.21

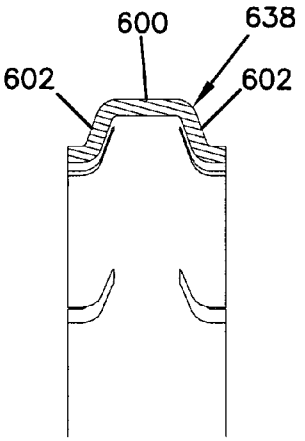
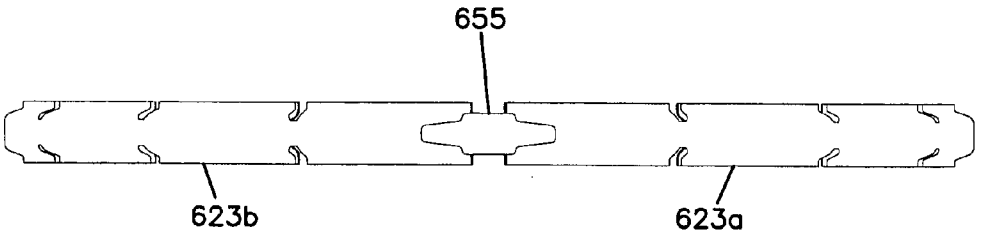


FIG.19



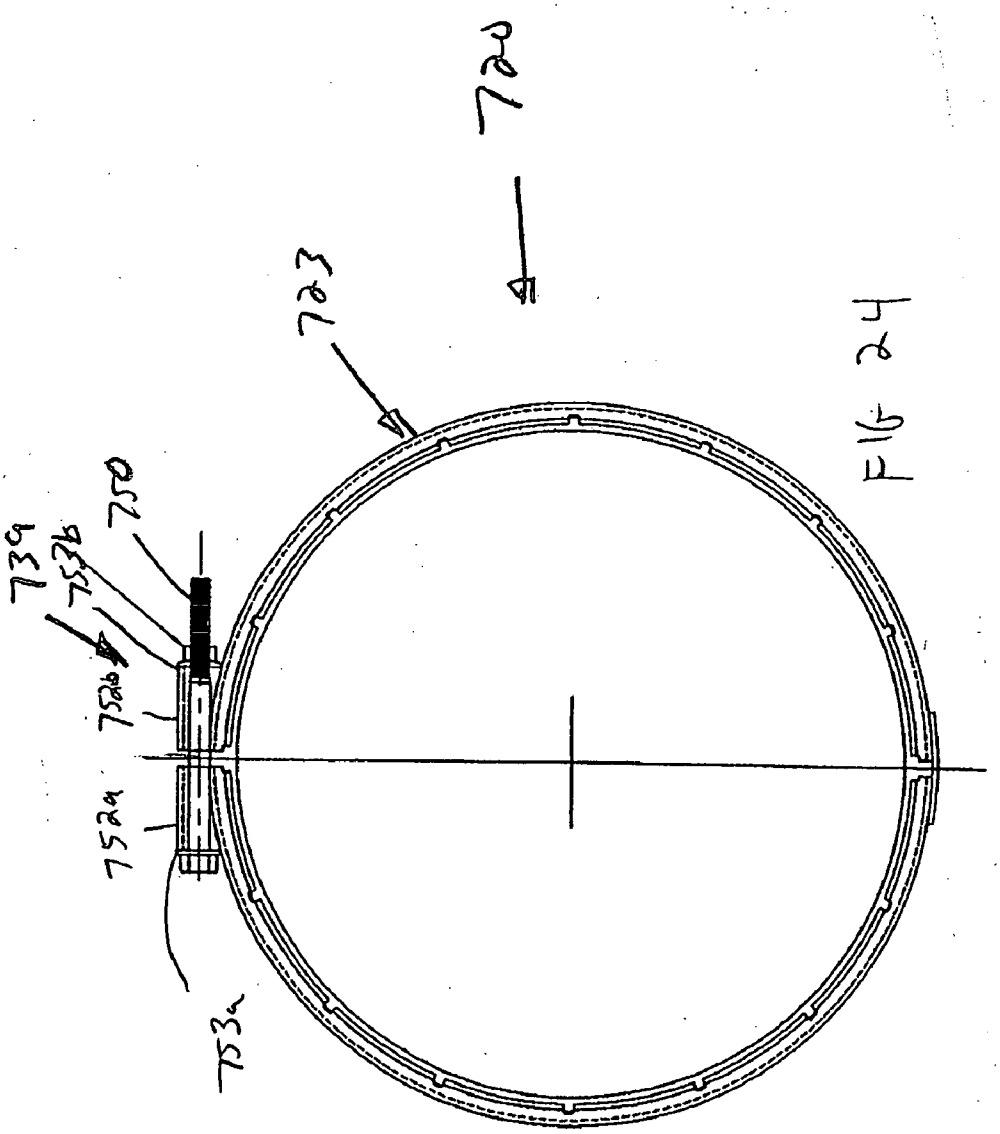


FIG 24

V-CHANNEL CLAMP

[0001] This application claims the benefit of U.S. Provisional Patent Application Ser. No. 60/691,505, filed Jun. 16, 2005 and U.S. Provisional Patent Application Ser. No. 60/734,740, filed Nov. 7, 2005, which applications are hereby incorporated by reference in their entirety.

TECHNICAL FIELD

[0002] The principles disclosed herein relate to clamps for coupling flanged conduits such as pipes or ducts. More particularly, the disclosure relates to clamps including channels having V-shaped cross-sections.

BACKGROUND OF THE INVENTION

[0003] FIG. **1** illustrates a prior art V-band clamp **20** for coupling flanged conduits. The clamp **20** includes an outer strap **22** having first and second looped ends **24** and **26**. First and second trunions **28**, **30** are respectively mounted within the first and second looped ends **24**, **26**. The first trunion **28** defines an internally threaded opening, and the second trunion **30** defines a clearance opening. The first and second looped ends **24**, **26** are fastened together by a bolt **32** that traverses a gap **34** between the looped ends **24**, **26**. The bolt **32** passes through the clearance opening of the second trunion **30** and is threaded into the internally threaded opening of the first trunion **28**. The clamp **20** is tightened by threading the bolt **32** into the first trunion **28** such that the gap **34** closes.

[0004] The clamp **20** also includes three channel members **36** secured to the inner side of the strap **22**. Each of the channel members **36** defines a generally V-shaped channel **38** (see FIG. **2**) that opens inwardly toward the center of the clamp. The channels **38** provide a means for receiving the flanges of a pair of flanged conduits desired to be coupled together.

[0005] FIG. **2** shows the clamp **20** being used to clamp a first conduit **40** to a second conduit **42**. The conduits **40**, **42** respectively include flanges **44**, **46**. To clamp the conduits **40**, **42** together, the flanges **44**, **46** are placed in an abutting end-to-end relationship to form a joint, and the clamp **20** is then mounted over the joint with the abutting flanges **44**, **46** inserted within the channels **38** of the channel members **36**. By tightening the bolt **32**, the clamp **20** draws the flanges **44**, **46** together to provide a secure connection between the conduits **40**, **42**.

[0006] Ideally, V-band clamps of the type described above provide an effective seal between the flange end faces of two conduits being clamped together. However, for a number of reasons, clamps of the type described above often fail to provide an adequate seal between two flanged conduits. Reasons for such failures include non-uniform clamping forces about the circumferences of the flanges, inadequate clamping forces, and the inability of clamps to effectively conform to irregularities in the shapes of the flanges.

SUMMARY

[0007] One inventive aspect of the disclosure relates to conduit clamps having structures adapted for providing a more uniform clamping force around the circumference of flanged conduits being clamped together as compared to prior art style V-band clamps.

[0008] Another inventive aspect of the disclosure relates to conduit clamps adapted to conform to variations in flange shape provide improved sealing performance.

[0009] A further inventive aspect of the disclosure relates to conduit clamps and to clamping systems having enhanced sealing capabilities.

[0010] A variety of additional inventive aspects will be set forth in the description that follows. The inventive aspects can relate to individual features and to combinations of features. It is to be understood that both the forgoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the broad inventive concepts upon which the embodiments disclosed herein are based.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** is an end view of a prior art clamp being used to interconnect two flanged pipes;

[0012] FIG. **2** is a cross-sectional view taken along section line **2-2** of FIG. **1**;

[0013] FIG. **3** is a front view of a clamp having features that are examples of inventive aspects in accordance with the principles of the present disclosure;

[0014] FIG. **4** is a cross-sectional view taken along section line **4-4** of FIG. **3**;

[0015] FIG. **5** is a cross-sectional view taken along section line **5-5** of FIG. **3**;

[0016] FIG. **6** is a front view of one of the channel segments of the clamp of FIG. **3**;

[0017] FIG. **7** is a right side view of the channel segment of FIG. **6**;

[0018] FIG. **8** is a plan view of the channel segment of FIG. **6** with the channel section laid flat prior to the channel being formed therein;

[0019] FIG. **9** is a front view of an alternative channel segment in accordance with the principles of the present disclosure;

[0020] FIG. **10** is a right side view of the channel segment of FIG. **9**;

[0021] FIG. **11** is a cross-sectional view taken along section line **11-11** of FIG. **9**;

[0022] FIG. **12** is a plan view of the channel segment of FIG. **9** with the channel section laid flat prior to the channel being formed therein;

[0023] FIG. **13** is a front view of another clamp having features that are examples of inventive aspects in accordance with the principles of the present disclosure;

[0024] FIG. **14** is a cross-sectional view taken along section line **14-14** of FIG. **13**;

[0025] FIG. **15** is a cross-sectional view taken along section line **15-15** of FIG. **13**;

[0026] FIG. **16** is a front view of one of the channel segments of the clamp of FIG. **13**;

[0027] FIG. **17** is a front view of a further clamp having features that are examples of inventive aspects in accordance with the principles of the present disclosure;

[0028] FIG. **18** is a left side view of the clamp of FIG. **17**;

[0029] FIG. **19** is a bottom view of the clamp of FIG. **17**;

[0030] FIG. **20** is a cross sectional view taken along section line **20-20** of FIG. **17**;

[0031] FIG. **21** is a cross sectional view taken along section line **21-21** of FIG. **17**;

[0032] FIG. **22** is a cross sectional view taken along section line **22-22** of FIG. **17**;

[0033] FIG. **23** is a cross sectional view taken along section line **23-23** of FIG. **17**; and

[0034] FIG. **24** is a front view of still another clamp having features that are examples of inventive aspects in accordance with the principles of the present disclosure.

DETAILED DESCRIPTION

[0035] Clamps in accordance with the principles of the present disclosure can be used to connect flanged conduits together. In certain embodiments, the conduits can be pipes such as exhaust pipes. In other embodiments, the conduits can be canisters or housings (e.g., muffler bodies) for holding exhaust aftertreatment devices such as catalytic converters, diesel particulate filters or other devices. Example aftertreatment devices and flange configurations are disclosed in U.S. provisional application Ser. Nos. 60/636,459; 60/662,904; and 60/678,870 that are incorporated herewith by reference in their entireties.

[0036] FIGS. **3-5** illustrate a clamp **120** having features that are examples of inventive aspects in accordance with the principles of the present disclosure. The clamp **120** includes a band structure **123** that encircles a center reference point **125**. The band structure **123** includes two channel segments **136**. In the depicted embodiment, the channel segments **136** are half-circles with interior sides opposing one another to generally form a circular band. The channel segments **136** each define a flange engagement channel **138** (e.g., generally V-shaped channels as shown in FIGS. **4** and **5**) adapted to receive the flanges (e.g., like flanges **44**, **46** of FIG. **2**) of two abutting flanged conduits desired to be joined together. Fasteners such as bolts **150** are secured (e.g., welded) to opposite ends of one of the channel segments **136**. The bolts **150** have base ends **151** secured to the outer surface of the channel segment **136** and free ends **153** that are threaded. The bolts **150** are generally tangentially aligned relative to the outer surface of the channel segment **136**. Sleeves **152** (i.e., tunnels) are secured (e.g., welded) to opposite ends of the other channel segment **136**. As shown at FIG. **3**, the sleeves **152** define passages **154** through which the bolts **150** extend. Gaps **156** are defined between the ends of the channel segments **136**. The clamp **120** is tightened by threading nuts on the threaded ends **153** of the bolts **150**. As the nuts are threaded on the bolts **150**, the nuts and engage end surfaces **156** of the sleeves **152** causing the channel segments **136** to be drawn together. As the channel segments **136** are drawn together, the gaps **156** close and the clamp is tightened.

[0037] By using two or more bolts **150** circumferentially separated from one another, the clamp **120** effectively distributes clamping force evenly along the channel segments **136**. The use of multiple fasteners also allows higher clamping forces to be generated than single fastener clamps. High clamping forces and effective clamping force distribution makes it easier to achieve leak free or reduced-leakage joints. These factors also assist in withstanding environmental forces, such as shock, vibration and thermal cycling, which are encountered when holding heavy exhaust aftertreatment devices together.

[0038] In the embodiments of FIG. **3**, two sleeves are provided on one of the channel segments and two bolts are provided on the other channel segment. This is advantageous because both bolts can be accessed from the same side of the clamp. However, in other embodiments, a bolt can be secured at one end of each channel section and a sleeve can be secured at the other end of each channel segment. This would promote manufacturing efficiency because both pieces of the clamp would have the same configuration. In still other embodiments, the channel segments can be reinforced along their entire lengths by U-bolt sections secured to the exterior of the channel segments.

[0039] The channel segments **136** can be pressed, formed, stamped rolled or otherwise made from a flat band of material. Example material for manufacturing the channel segments **136** include steel, stainless steel, or other materials. In certain embodiments, the band can have a thickness t in the range of 0.05-0.25 inches. In other embodiments, the band can have a thickness t in the range of 0.07-0.125 inches. In still other embodiments, the band can have a thickness of about 0.098 inches.

[0040] Referring to FIG. **4**, the channel segments **136** can have transverse cross-sections that define generally V-shaped channels **138**. As shown at FIG. **4**, the channel segments **136** include base portions **200** and legs **202** that project inwardly from the base portions **200**. The legs **202** diverge as the legs extend away from the base portion **200** to generate the V-shaped channel. While V-shaped channels are preferred, other channel shapes could also be used.

[0041] Referring to FIGS. **6-9**, the channel segments **136** each define a plurality of notches **300** for increasing the flexibility of the segments **136**, and for allowing the segments **136** to better conform to shape irregularities in the flanges being clamped. In a preferred embodiment, the notches **300** cut completely through the legs **202** to the base portions **200**. In this way, a plurality of separate clamping members **136***a-h* are provided at each channel segment **136**. The notches **300** allow the clamping members to independently grip and conform to relatively short sections of flange. In this way, adjacent clamping members generally do not influence one another thereby allowing the clamp to better accommodate localized size variations in the flanges being clamped. In one embodiment, at least 3 separate clamping members are provided per channel segment. In another embodiment, at least 4 separate clamping members are provided per channel segment. In still another embodiment, at least 5 separate clamping members are provided per channel segment. In the depicted embodiment, 8 clamping members are provided per channel segment.

[0042] While it is preferred for the notches to be sized to provide independent gripping members on each channel segment, smaller notches can also be used. For example,

FIGS. **9-12** show a channel segment **136'** having notches **300'** that do not extend completely through the legs of the channel segments.

[**0043**] Referring again to FIGS. **6-8**, the notches **300** define flex regions **310** positioned between each of the separate clamping members **136***a-h*. The flex regions **310** allow the clamp to flex to better conform to the shape of the flanges being clamped. In one embodiment, the bolts **150** and the channels segments **136** are made of stainless steel, the flex regions **310** have cross-sectional areas of at least 20 percent the cross-sectional are of each bolt. In other embodiments, the flex regions have cross-sectional areas of at least 30, 40, 50, 60, 70 or 80 percent of the cross-sectional area of each bolt. Preferably, the flex regions have sufficient cross-sectional area to prevent failure during normal use. In certain embodiments, the cross-sectional areas of the flex regions **310** can be designed to allow slight stretching of the flex regions as the clamp **120** is tightened.

[**0044**] FIGS. **13-16** show an alternative clamp **520** in accordance with the principles of the present disclosure. The clamp **520** includes 3 channel segments **536** that cooperate to defined a circular band structure. A bolt **150** and a sleeve **152** are secured to the ends of each channel segment **536**. The channel segments **536** are not notched.

[**0045**] Vehicle exhaust systems can often include heat shields that surround certain components of the systems to prevent relatively hot components from being exposed. For example, heat shields are often provided around the exterior of vertical mufflers on trucks. An example heat shield around a vertical muffler can be spaced about 1 inch from the vertical muffler and often wraps around ½to ¾of the circumference of the muffler. Heat shields can make it difficult to access clamps positioned beneath the shields.

[**0046**] FIGS. **17-22** illustrate a further clamp **620** having features that are examples of inventive aspects in accordance with the principles of the present disclosure. The clamp **620** includes a band structure **623** that encircles a center reference point **625**. The band structure **623** defines a flange engagement channel **638** (e.g., a generally v-shaped channel as shown at FIG. **21**) adapted to receive the flanges of two abutting flanged conduits desired to be joined together. The clamp **620** includes a fastening arrangement **639** for tightening (i.e., constricting the diameter of the band structure **623**) and/or loosening (i.e., enlarging the diameter of the band structure **623**) the clamp **620**. The fastening arrangement **639** is positioned at a single circumferential location of the clamp **620**. By having a single fastening arrangement located at a single circumferential position of the clamp, the fastening arrangement can be readily positioned at the uncovered portion of a shielded exhaust system component. For example, when the clamp **620** is used to interconnect two portions of a shielded vertical muffler, the band structure **623** extends between the shield and the vertical muffler, and the fastening arrangement **639** is located at the gap between the ends of the shield. By positioning the fastening arrangement **639** at the gap between the ends of the shield, the fastening arrangement can be readily accessed to loosen, tighten, remove, install or otherwise access the clamp.

[**0047**] The fastening arrangement **639** includes a first sleeve **652***a* secured to one end of the band structure **623**, and a second sleeve **652***b* secured to the other end of the band structure **623**. The first sleeve **652***a* defines a non-threaded internal opening sized for slidably receiving a fastener such as a bolt **650**. The sleeve **652***b* is internally threaded with threading that matches the threading of the bolt **650**. When the clamp **620** is assembled, the openings of the first and second sleeves **652***a*, **652***b* are generally coaxially aligned. By inserting the bolt **650** through the first sleeve **652***a*, and threading the bolt into the second sleeve **652***b*, the ends of the band structure **623** can be drawn together to tighten the clamp **620**. By turning the bolt **650** in the opposite direction, the bolt unthreads from the second sleeve **652***b* causing the gap between the ends of the band structure **623** to enlarge and the clamp to loosen. The bolt **650** is shown including a head **651** that seats upon a seating surface **653** of the first sleeve **652***a*.

[**0048**] Referring to FIG. **17**, the band structure **623** includes a plurality of pairs of notches **300** for dividing the band structure **623** into a plurality of separate clamping members **623***a*-**623***p*. The clamping members **623***a*-**623***p* operate similar to those previously described in the embodiments of FIGS. **6-9**. In certain embodiments, the band structure **623** includes at least 6, 8, 10, 12, 14 or 16 separate clamping members.

[**0049**] As shown at FIG. **20**, the notches **300** preferably cut essentially completely through legs **602** of the flange engagement channel **638** to base portion **600** of the flange engagement channel **638**. The cross sectional area of the band structure **623** at the notch locations (see FIG. **20**) is preferably at least 50-80% of the transverse cross sectional area of the bolt **650**. It will be appreciated that the band structure **623** is preferably designed so that the notched areas of the band structure **623** have sufficient cross sectional area to prevent failure during normal use. Therefore, depending upon the intended applications and tightening forces required, the cross sectional areas of the notched regions of the band structure **623** can vary from those specifically described herein.

[**0050**] It will be appreciated that the band structure **623** can be designed with cross sectional areas and thicknesses in accordance with those previously described in the application for other band structure embodiments described herein. Depending upon the application, other thicknesses than those specifically described can also be used.

[**0051**] Referring to FIG. **17**, the band structure **623** is defined by two channel segments **636***a*, **636***b*that are half circles with interior sides imposing one another to form the generally circular band. The channel segments **636***a*, **636***b*are joined at their upper ends by the fastening arrangement **639** and are joined at their lower ends by a connection piece **655**. The connection piece **655** is depicted as a strap or other metal piece affixed, fastened or otherwise secured to the lower ends of the channel segments **636***a*, **636***b*. In certain embodiments, the connector piece **655** can function as a flexible hinge for facilitating flexing apart the upper ends of the band structure **623** to enlarge the diameter of the band structure **623** during installation. In other embodiments, the band structure **623** can have a one piece construction in which the connector piece **655** is replaced by a unitary/integral connection at the bottom of the band structure **623**.

[**0052**] It will be appreciated that the two piece configuration of the band structure **623** has manufacturing advantages because the separate half pieces can more readily be

manufactured using a die forming technique. In contrast, one-piece band structures would most likely by manufactured using other types of forming techniques such as roll forming.

[0053] FIG. **24** illustrates a further clamp **720** having features that are examples of inventive aspects in accordance with the principles of the present disclosure. Similar to the clamp of FIG. **17**, the clamp **720** includes a band structure **723** having a fastening arrangement **739** positioned at a single circumferential location of the band structure **723**. The depicted fastening arrangement **739** includes first and second non-threaded sleeves **752***a*, **752***b* secured to the ends of the band structure **723**. The sleeves **752***a*, **752***b* non-threadably receive a fastener such as a bolt **750**. The first and second sleeves **752***a*, **752***b* include seating surfaces **753***a*, **753***b*. When the clamp **720** is assembled, the head of the bolt **750** seats on the seating surface **753***a*, and a nut threaded upon the bolt **750** seats against the seating surface **752***b*. To eliminate the need to use two wrenches to tighten or loosen the fastening arrangement, the fastening arrangement preferably includes a structure for preventing the rotation of either the bolt **750** or the nut. For example, the bolt can have a noncircular (e.g., hex shaped) cross section that fits within a corresponding noncircular cross section of the first sleeve **752***a*. Alternatively, the nut can be welded or otherwise connected to the second sleeve **752***b* to prevent rotation of the nut during tightening. In other embodiments, internal threads can be provided within the second sleeve **752***b* to eliminate the need for a separate nut.

[0054] To further improve force distribution, in certain embodiments, the inner surfaces of the channel segment can be covered with an anti-friction coating such as molybdenum disulfide or other material for reducing the coefficient of friction of the channel segments.

[0055] To provide corrosion resistance (e.g., by preventing galvanization), the nut and the bolt can be made of different materials. For example, in one embodiment, one of the nut and the bolt can be made of stainless steel and the other of the nut and the bolt can be made of mild steel or plated steel (e.g., zinc plated steel).

[0056] From the forgoing detailed description, it will be evident that modifications and variations can be made in the devices of the disclosure without departing from the spirit or scope of the invention.

What is claimed is:

1. A clamp comprising:

a channel structure defining a circumference that generally encircles a center reference point, the channel structure having first ends that are drawn together for tightening the clamp, channel structure having a base portion and first and second legs that extend away from the base portion so as to define a generally v-shaped cross-section;

a first fastener for drawing the first ends of the channel structure together to tighten the clamp; and

the channel structure defining at least 6 flex regions spaced about the circumference of the channel structure, each flex region including a first notch defined within the first leg of the channel structure and a second notch defined within the second leg of the channel structure.

2. The clamp of claim 1, wherein at least 8 of the flex regions are provided about the circumference of the channel structure.

3. The clamp of claim 1, wherein at least 10 of the flex regions are provided about the circumference of the channel structure.

4. The clamp of claim 1, wherein the channel structure includes two half-circle segments.

5. The clamp of claim 4, wherein the channel structure includes second ends that are joined by a flexible hinge.

6. The clamp of claim 4, wherein the channel structure includes second ends, and wherein the clap includes a second fastener for drawing the second ends of the channel structure together to tighten the clamp.

7. The clamp of claim 1, further comprising first and second sleeves welded to channel structure adjacent the first ends of the channel structure, the first fastener being received within the first and second sleeves.

8. The clamp of claim 7, wherein the fastener includes a bolt, and wherein clamp further includes a nut into which the bolt threads.

9. The clamp of claim 8, wherein the nut is welded to one of the first and second sleeves.

10. The clamp of claim 1, wherein the fastener includes a bolt welded to the channel structure adjacent one of the first ends, and wherein the clamp includes a sleeve for receiving the bolt, the sleeve being welded to the other of the first ends of the channel structure.

11. The clamp of claim 1, wherein the first and second notches at each flex region extend completely through the first and second legs of the channel structure to the base portion of the channel structure.

12. A clamp comprising:

a channel structure defining a circumference that generally encircles a center reference point, the channel structure having first ends that are drawn together for tightening the clamp, channel structure having a base portion and first and second legs that extend away from the base portion so as to define a generally v-shaped cross-section;

a first fastener for drawing the first ends of the channel structure together to tighten the clamp; and

the channel structure defining notch regions spaced about the circumference of the channel structure, each notch region including a first notch defined within the first leg of the channel structure and a second notch defined within the second leg of the channel structure, wherein the notch regions divide the channel structure into at least 6 separate clamping elements.

13. The clamp of claim 12, wherein at least 8 of the separate clamping elements are provided about the circumference of the channel structure.

14. The clamp of claim 12, wherein at least 10 of the separate clamping elements are provided about the circumference of the channel structure.

15. A clamp comprising:

a channel structure defining a circumference that generally encircles a center reference point, the channel structure having ends that are drawn together for tight-

ening the clamp, channel structure having a base portion and first and second legs that extend away from the base portion so as to define a generally v-shaped cross-section;

first and second sleeves welded to the channel structure adjacent the ends of the channel structure; and

a bolt for drawing the first ends of the channel structure together to tighten the clamp, the bolt being received in the first and second sleeves.

16. The clamp of claim 15, wherein the channel structure defining notch regions spaced about the circumference of the channel structure, each notch region including a first notch defined within the first leg of the channel structure and a second notch defined within the second leg of the channel structure, wherein the notch regions divide the channel structure into separate clamping elements, and wherein the channel structure includes at least 16 separate clamping elements.

17. The clamp of claim 15, wherein the channel structure includes two half-circle segments joined by a flexible hinge.

18. The clamp of claim 15, wherein clamp further includes a nut into which the bolt threads.

19. The clamp of claim 18, wherein the nut is welded to one of the first and second sleeves.

20. A clamp comprising:

a channel structure defining a circumference that generally encircles a center reference point, the channel structure having a base portion and first and second legs that extend away from the base portion so as to define a generally v-shaped cross-section, the channel structure including first, second and third channel segments;

a first fastener for drawing the first and second channel segments together to tighten the clamp;

a second fastener for drawing the second and third channel segments together to tighten the clamp; and

a third fastener for drawing the first and third channel segments together to tighten the clamp.

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